"Method and Apparatus for Hierarchical Z Buffering and
Stenciling"
Inventors: Larry D. Seiler et al.
Attorney Docket No.: 00100.02.0004

FIG. 1

FIG. 4

"Method and Apparatus for Hierarchical Z Buffering and Stenciling"
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FIG. 2

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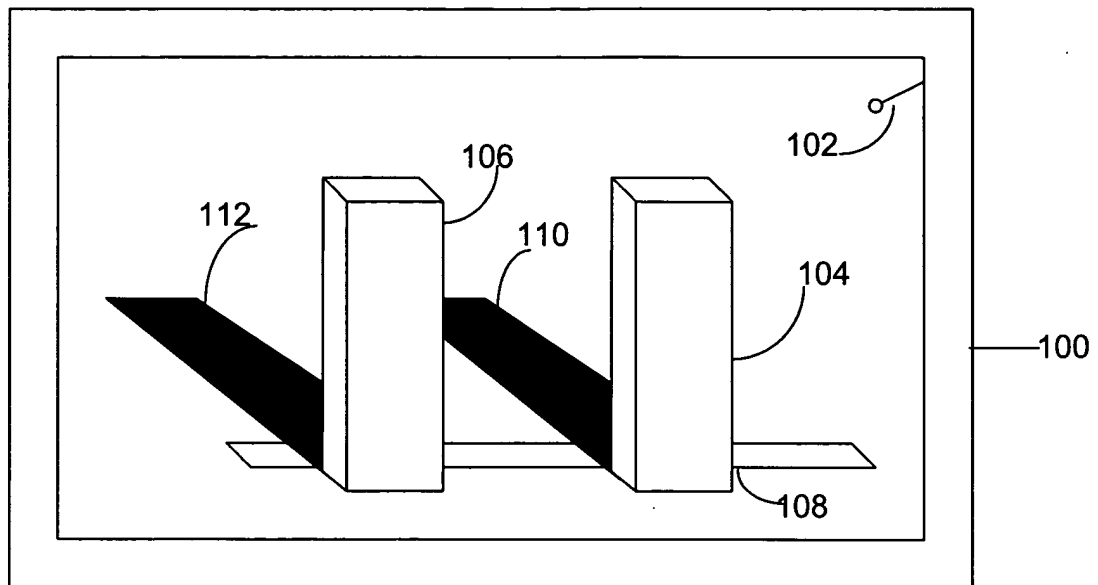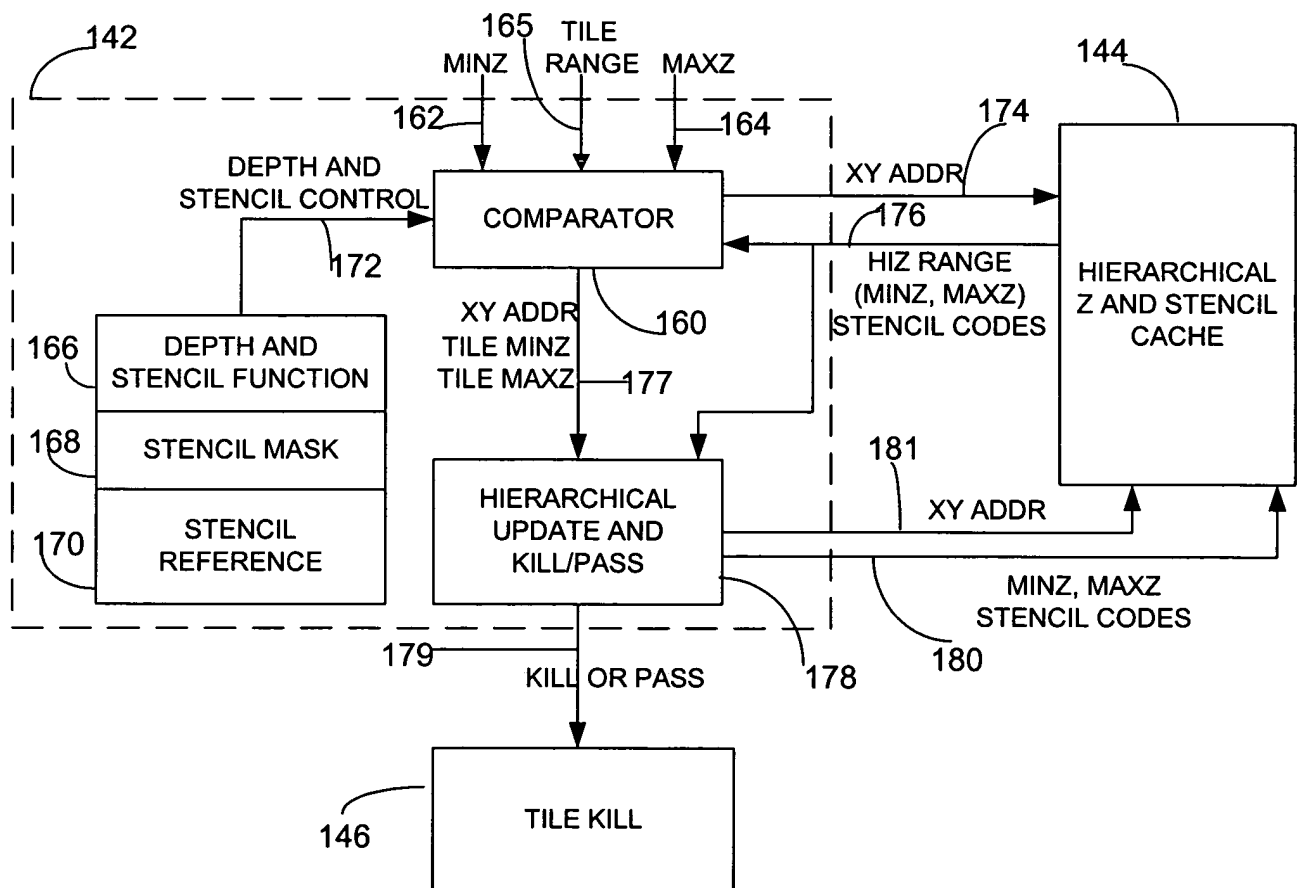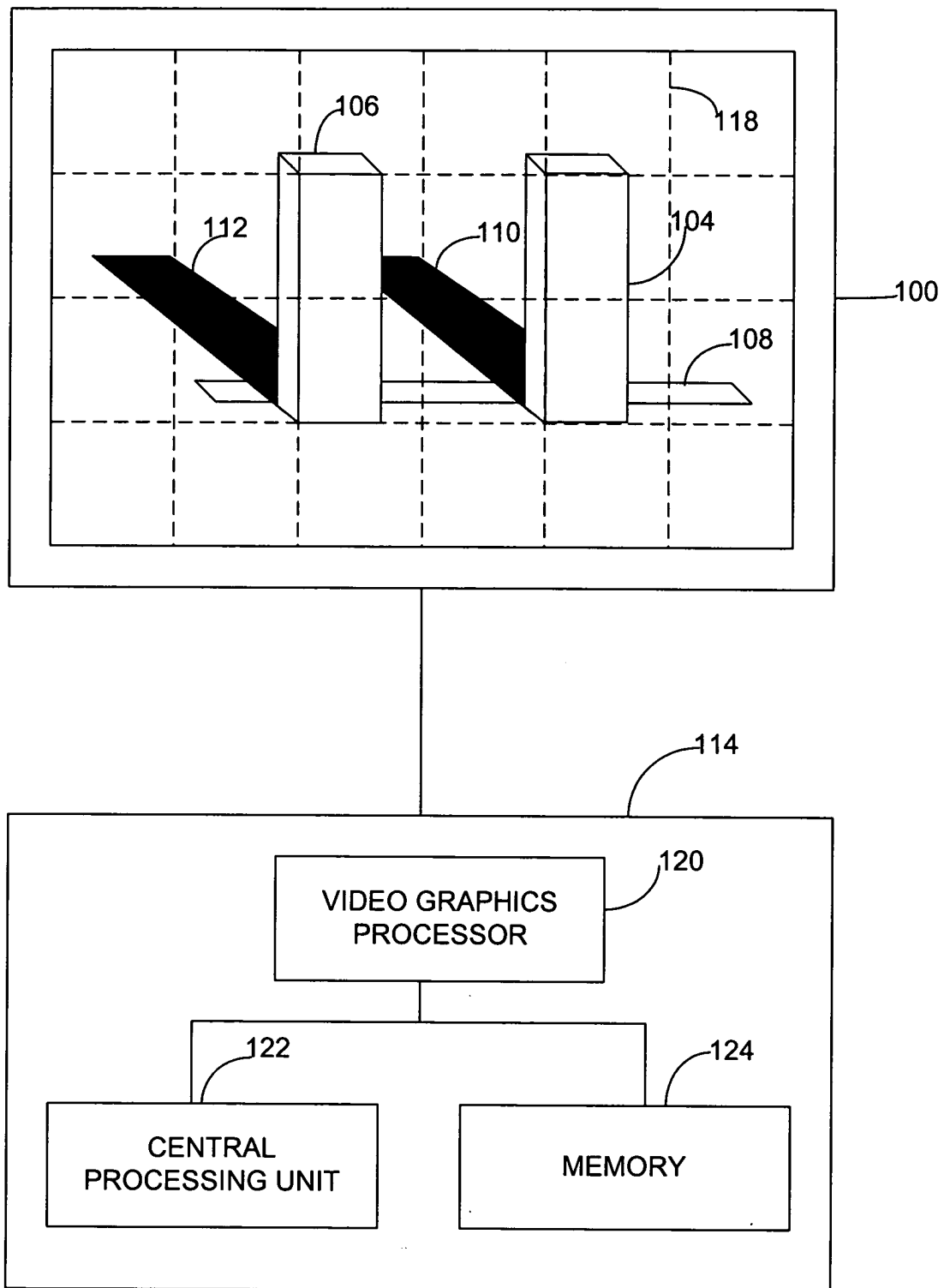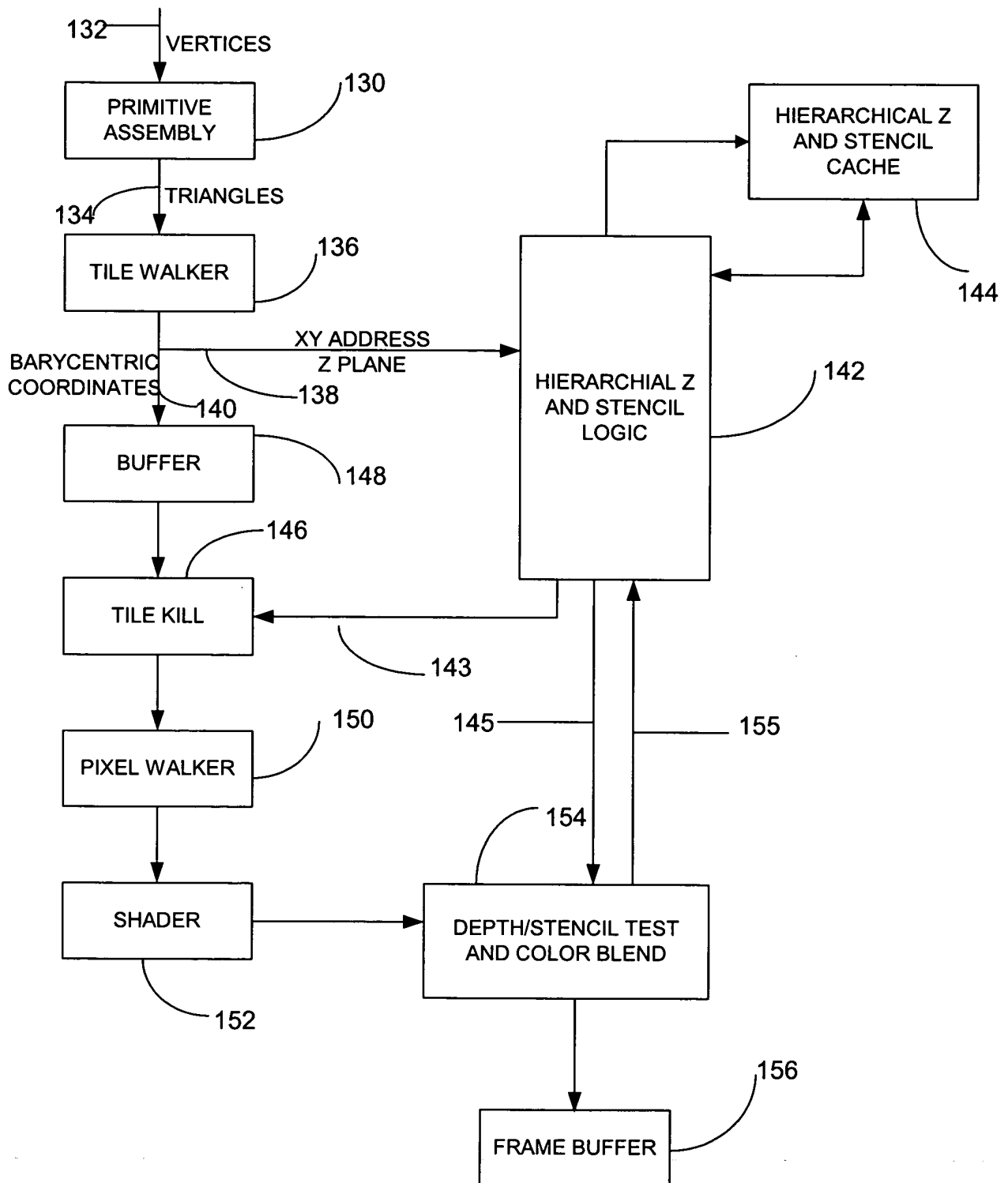Attorney Docket No.: 00100.02.0004

FIG. 3

"Method and Apparatus for Hierarchical Z Buffering and Stenciling"
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START —200

COMPARING A TILE Z VALUE RANGE HAVING A TILE MINZ AND A TILE MAXZ WITH A HIERARCHICAL Z VALUE RANGE HAVING A H-CACHE MINZ AND A H-CACHE MAXZ AND A STENCIL CODE

202

UPDATING THE HEIRACHICAL Z VALUE RANGE AND STENCIL CODE IN RESPONSE THERETO

204

DETERMINING WHETHER TO RENDER A PLURALITY OF PIXELS WITHIN THE TILE BASED ON THE COMPARISON OF THE TILE WITH THE HIERARCHICAL Z VALUE RANGE AND THE STENCIL CODE

206

208

FAIL — STENCIL TEST?

PASS

210

FAIL — HIZ TEST? — PASS

212 KILL TILE

214 RENDER PIXELS

END —216

FIG. 5

220 START

222
RECEIVING A TILE HAVING A PLURALITY OF PIXELS

224
DETERMINING IF THE TILE IS VISIBLE RELATIVE TO A STENCIL BY GENERATING A STENCIL CODE AND COMPARING THE STENCIL CODE TO A STENCIL VALUE AND A MASK

226
DETERMINING IF THE TILE IS VISIBLE IN A HIERARCHICAL Z PLANE BY RECEIVING A MINZ AND A MAXZ FOR THE TILE, COMPARING THE MINZ AND THE MAXZ TO A HIERARCHICAL Z RANGE AND WHEREIN AT LEAST ONE OF THE PLURALITY OF PIXELS IS VISIBLE IN THE Z PLANE

228
GENERATING AN INDICATOR WHEREIN THE INDICATOR INDICATES A POSITIVE INDICATION WHEN IT IS DETERMINED THAT THE TILE IS VISIBLE RELATIVE TO A STENCIL AND VISIBLE IN A HIERARCHICAL Z PLANE AND A NEGATIVE INDICATION WHEN IT IS DETERMINED THAT THE TILE IS NOT VISIBLE RELATIVE TO THE STENCIL OR IN THE HIERCHICAL Z PLANE

230
RENDERING THE PIXELS OF THE TILE IF THE INDICATOR INDICATES A POSITIVE INDICATION AND KILLING THE IF THE INDICATOR INDICATES A NEGATIVE INDICATION

232
UPDATING THE HIERARCHICAL Z VALUE RANGE AND STENCIL CODE IN RESPONSE THERETO

234 END

FIG. 6

"Method and Apparatus for Hierarchical Z Buffering and
Stenciling"
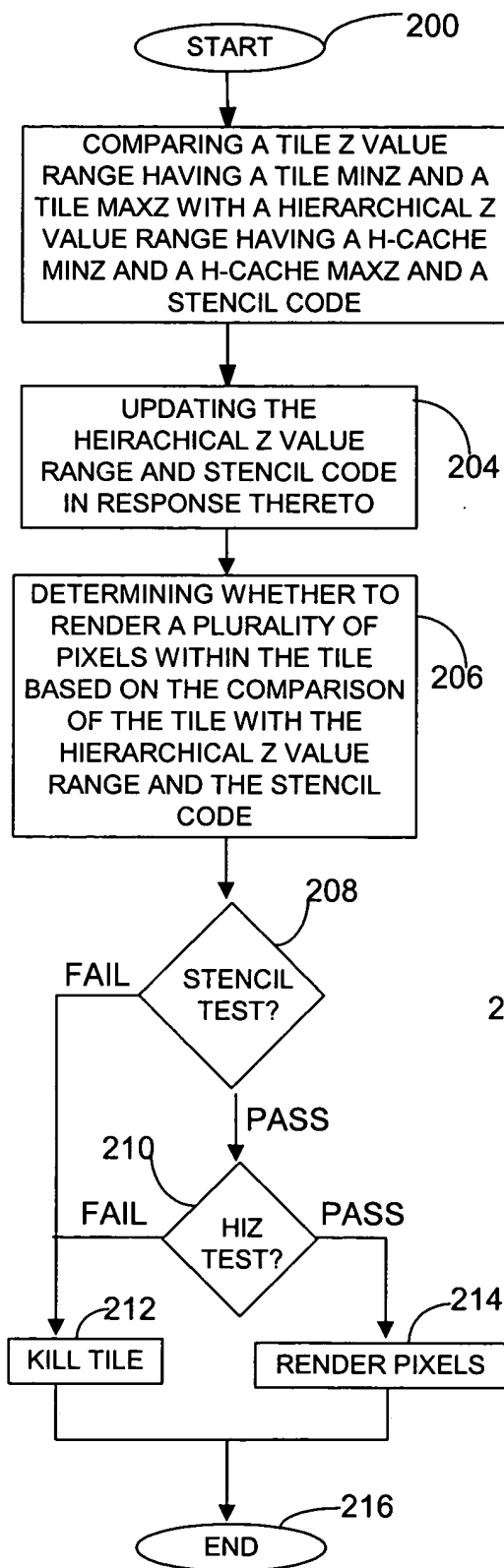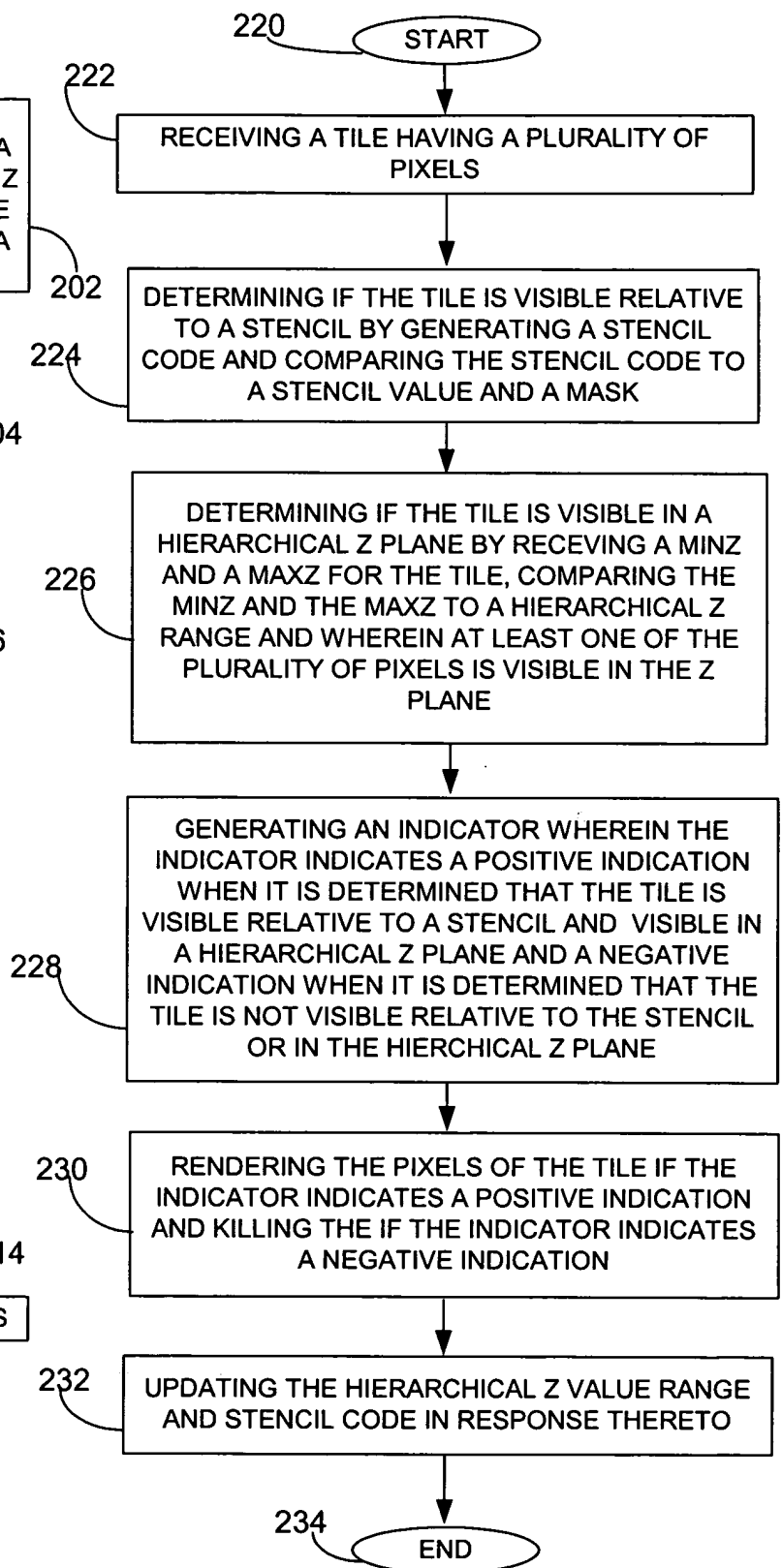Inventors: Larry D. Seiler et al.
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><=	Name	Description
000	Background	Replace all stencil values with background when reading the tile from memory
001	Equal	Background value is equal to all stencil values.
010	Less	Background value is less than all stencil values.
011	Lequal	Background value less than or equal to all stencil values.
100	Greater	Background value is greater than all stencil values.
101	Gequal	Background value is equal to or greater than all stencil values.
110	Notequal	Background value is greater than or less than all stencil values, but not equal to any stencil values.
111	Unknown	Nothing is known about how the background value compares to the stencil values.

FIG. 7

Stencil Code	Stencil Function							
	Never	Always	Less	Lequal	Equal	Gequal	Greater	Nequal
Bkg	Fail	Pass	Fail	Pass	Pass	Both	Fail	Fail
Equal	Fail	Pass	Fail	Pass	Pass	Both	Fail	Fail
Less	Fail	Pass	Pass	Pass	Fail	Fail	Fail	Pass
Lequal	Fail	Pass	Both	Pass	Both	Both	Fail	Both
Greater	Fail	Pass	Fail	Fail	Fail	Pass	Pass	Pass
Gequal	Fail	Pass	Fail	Both	Both	Pass	Both	Both
Nequal	Fail	Pass	Both	Both	Fail	Both	Both	Pass
Unknwn	Fail	Pass	Both	Both	Both	Both	Both	Both

FIG. 8

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Stencil Code	Keep	Zero Bkg>0	Zero Bkg 0	Replace Bkg	Incr Bkg < ~1	Incr Bkg ~1	Decr Bkg>0	Decr Bkg 0	Invert Bkg hi 1	Invert Bkg hi 0
										Stencil Operation
Bkg	Bkg	Less	Equal	Bkg	Greater	Equal	Less	Equal	Less	Greater
Equal	Equal	Less	Equal	Equal	Greater	Equal	Less	Equal	Less	Greater
Less	Less	Less	Equal	Equal	Lequal	Lequal	Less	*	Unknwn	Greater
Lequal	Lequal	Less	Equal	Equal	Unknwn	Lequal	Less	*	Unknwn	Greater
Greater	Greater	Less	Equal	Equal	Greater	*	Gequal	Gequal	Less	Unknwn
Gequal	Gequal	Less	Equal	Equal	Greater	*	Unknwn	Gequal	Less	Unknwn
Nequal	Nequal	Less	Equal	Equal	Unknwn	Unknwn	Unknwn	Unknwn	Unknwn	Unknwn
Unknwn	Unknwn	Less	Equal	Equal	Unknwn	Unknwn	Unknwn	Unknwn	Unknwn	Unknwn

FIG. 9

"Method and Apparatus for Hierarchical Z Buffering and
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Depth Comparison	Depth Function							
	Never	Always	Less	Lequal	Equal	Gequal	Greater	Nequal
Pmax < Tmin	Fail Tmin: Tmax	Pass Pmin: Tmax	Pass Pmin: Tmax	Pass Pmin: Tmax	Fail Tmin: Tmax	Fail Tmin: Tmax	Fail Tmin: Tmax	Pass Pmin: Tmax
Pman ≥ Tmin Pmin < Tmin Pmax ≤ Tmax	Fail Tmin: Tmax	Pass Pmin: Tmax	Both Pmin: Tmax	Both Pmin: Tmax	Both Tmin: Tmax	Both Tmin: Tmax	Both Tmin: Tmax	Both Pmin: Tmax
Pmin < Tmin Pmax > Tmax	Fail Tmin: Tmax	Pass Pmin: Pmax	Both Pmin: Tmax	Both Pmin: Tmax	Both Tmin: Tmax	Both Tmin: Pmax	Both Tmin: Pmax	Both Pmin: Pmax
Pmin > Tmin Pmax < Tmax	Fail Tmin: Tmax	Pass Tmin: Pmax	Both Tmin: Tmax	Both Tmin: Tmax	Both Tmin: Tmax	Both Tmin: Pmax	Both Tmin: Tmax	Both Tmin: Tmax
Pmin ≤ Tmax Pmin > Tmin Pmax > Tmax	Fail Tmin: Tmax	Pass Tmin: Pmax	Both Tmin: Tmax	Both Tmin: Tmax	Both Tmin: Tmax	Both Tmin: Pmax	Both Tmin: Pmax	Both Tmin: Pmax
Pmin > Tmax	Fail Tmin: Tmax	Pass Tmin: Pmax	Fail Tmin: Tmax	Fail Tmin: Tmax	Fail Tmin: Tmax	Pass Tmin: Pmax	Pass Tmin: Pmax	Pass Tmin: Pmax

FIG. 10